

54. (Amended) The apparatus of claim 75, wherein the actuator is configured to move both the target object and the reflection member while maintaining a constant distance between the target object and the reflection member.

Please cancel claim 55 without prejudice.

Please amend claims 57, 60-61, and 63 as follows:

57. (Amended) A lens element, of which the optical characteristic is a surface profile measured using an apparatus as recited in claim 75.

60. (Amended) The apparatus of claim 75, wherein the target object is a lens element.

61. (Amended) A lens element, of which the optical characteristic is a wavefront aberration measured using an apparatus as recited in claim 75.

63. (Amended) A projection lens system, of which the optical characteristic is a wavefront aberration measured using an apparatus as recited in claim 75.

REMARKS

Consideration and entry of the foregoing amendments are requested before commencing substantive examination.

The amendments herein are in response to the Restriction Requirement of March 25, 2003, in which the examiner contended that pending claims are directed to two "patentably distinct" species. The Restriction Requirement also contended there were no generic claims in the application. This Amendment is made to provide such generic claims.

First, to satisfy the requirement of making an election, Applicants elect, with traverse, the claims that allegedly are directed to the species shown in FIG. 1 (*i.e.*, claims 1-10, 21-32, and 46-50, wherein claims 1, 21, and 46 are independent).

In this Amendment, claims 1, 4-5, 7, 21, 23-24, 26, 28-32, 34-37, 44-50, 52-54, 57, 60-61, and 63 are amended; claims 11-20, 33, 38-43, 51, and 55 are canceled without prejudice;

claims 2-3, 6, 8-10, 22, 25, 27, 56, 58-59, and 62 are unchanged; and new claims 64-77 are submitted for consideration. Note that these amendments resulted in the cancellation of independent claims 11, 33, and 51. As a result of the amendments herein, claims 1-10, 21-32, 34-37, 44-50, 52-54, and 57-77 are pending.

Specifically:

(a) Independent claim 1 is amended to render the claim generic to claims 1 and 11. This resulted in the cancellation of independent claim 11.

(b) Claims 4, 5, and 7 are amended and new claims 64-65 are added in view of the amendments to claim 1. All these claims, along with claims 2-3, 6, and 8-10 that are unchanged, depend from claim 1.

(3) Independent claim 21 is amended to render the claim generic to claims 21 and 33. This resulted in the cancellation of independent claim 33.

(4) Claims 23-24, 26, 28-31, 32, 34-37, 44, and 45 are amended and new claims 66-73 are added in view of the amendments to claim 21. All these claims, along with claims 22, 25, and 27 that are unchanged, depend from claim 21.

(5) Independent claim 46 is amended to render the claim generic to claims 46 and 51. This resulted in the cancellation of independent claim 51.

(6) Claims 47-50, 52-54, 57, 60-61, and 63 are amended and new claims 74-77 are added in view of the amendments to claim 46. All these claims, along with claims 56, 58-59, and 62 that are unchanged, depend from claim 46.

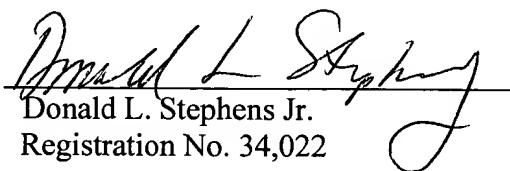
Support for all the claim amendments can be found in the claims as initially filed. Hence, no new matter is submitted.

Respectfully submitted,

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**Marked-up Version of Amended Claims
Pursuant to 37 C.F.R. §§ 1.121(b)-(c)**

1. (Amended) An apparatus for measuring [a surface profile] an optical characteristic of a target [surface] object, comprising:

 a light source configured to produce a light flux;

 a light-flux optical system situated relative to the light source and the target [surface] object and configured to (i) produce from the light flux a measurement-light flux and a reference-light flux, (ii) direct the measurement-light flux to the target [surface] object so as to [reflect from] cause the measurement-light flux to interact with the target [surface] object and thus acquire a wavefront profile corresponding to the optical characteristic of the target object, (iii) provide the reference-light flux with a standard wavefront, and (iv) establish an interference between the reference-light flux and the measurement-light flux [reflected] from the target [surface] object;

 a phase-state changing device situated and configured to change, relative to a standard, a phase state of at least one of the reference-light flux and the measurement-light flux [relative to a standard] from the target object;

 a detector situated and configured to detect interference fringes produced by the interference at any of the various phase states; and

 a computer connected to the detector and to the phase-state changing device, the computer being configured to produce, from the detected interference fringes produced at different respective phase states, data concerning respective phase distributions, and to calculate an average phase distribution.

4. (Amended) The apparatus of claim 1, wherein the phase-state changing device is configured to change the phase state of both the reference-light flux and the measurement-light flux, from the target object, a same amount relative to the standard, while maintaining a constant phase difference between the reference-light flux and the measurement-light flux from the target object.

5. (Amended) The apparatus of claim 1, further comprising a phase-modulation device situated and configured to produce a phase modulation of the measurement-light flux from the target object.

7. (Amended) The apparatus of claim 1, wherein:
the measurement-light flux from the target object has a frequency that is slightly different than a frequency of the reference-light flux; and
the interference is heterodyne interference.

Please cancel claims 11-20 without prejudice.

Please add the following new claims:

64. (New) The apparatus of claim 1, wherein:
the optical characteristic pertains to a surface profile of a reflective target surface of the target object; and
the light-flux optical system is configured to direct the measurement-light flux to the target surface so as to reflect from the target surface, and to establish an interference between the reference-light flux and the measurement-light flux reflected from the target surface.

65. (New) The apparatus of claim 1, wherein:
the optical characteristic pertains to a wavefront aberration profile of the target object; and
the light-flux optical system is configured to direct the measurement-light flux to the target object so as to be transmitted through the target object, and so as to establish an interference between the reference-light flux and the measurement-light flux transmitted through the target object.

Please amend claims 21, 23-24, 26, and 28-31 as follows:

21. (Amended) A method for measuring [a surface profile] an optical characteristic of a target [surface of an] object, comprising the steps:

(a) directing a measurement-light flux to the target [surface] object so as to cause the measurement-light flux to [reflect from]interact with the target [surface] and thus acquire a wavefront profile corresponding to the optical characteristic of the target object;

(b) providing a reference-light flux having a standard wavefront produced by reflection from a standard surface;

(c) establishing a mutual interference between the reference-light flux and the measurement-light flux from the target object;

(d) detecting a respective phase-difference interference pattern produced by the interference;

(e) moving [at least one of] the standard surface and optionally the target [surface] object [and the standard surface] a respective specified distance from a respective standard position and then repeating steps (a)-(d), the respective specified distance being appropriate to change a phase state of the at least one of the light fluxes a specified amount;

(f) repeating step (e) to obtain respective phase-difference interference patterns at multiple phase states; and

(g) determining an average phase-difference distribution of the target [surface] object from the respective phase-difference interference patterns obtained at the multiple phase states.

23. (Amended) The method of claim 21, wherein step (e) comprises moving the target [surface] object.

24. (Amended) The method of claim 21, wherein step (e) comprises moving both the target [surface] object and the standard surface while maintaining a constant phase difference between the reference-light flux and the measurement-light flux.

26. (Amended) The method of claim 21, wherein;
step (e) comprises moving the target [surface] object; and

step (d) is performed by phase-shift interference involving phase modulation of the reference-light flux.

28. (Amended) The method of claim 21, wherein, in step (e), the at least one of the target surface object and the standard surface is moved so as to change the phase state in a respective increment, relative to the standard, of 0, $\pi/2$, π , and $3\pi/2$.

29. (Amended) The method of claim 21, wherein, in step (e), the at least one of the target surface object and the standard surface is moved so as to change the phase state in a respective increment, relative to the standard, of 0, $\pi/4$, $\pi/2$, $3\pi/4$, π , $5\pi/4$, $3\pi/2$, and $7\pi/4$.

30. (Amended) The method of claim 21, wherein, in step (e), the at least one of the target surface object and the standard surface is moved so as to change the phase state by one or more irregular increments, relative to the standard, of from 0 to 2π and more than 2π as a whole.

31. (Amended) The method of claim 21, wherein the target object is an optical element.

Please add the following new claim:

66. (New) The method of claim 31, wherein the optical element is a lens element.

Please amend claim 32 as follows:

32. (Amended) An optical element, [comprising a target surface] having [a surface profile] an optical characteristic measured using the method of claim 21.

Please add the following new claims:

67. (New) The method of claim 32, wherein the optical characteristic is a wavefront aberration.

68. (New) The method of claim 32, wherein the optical element comprises a target surface having a surface profile measured using the method of claim 21.

Please cancel claim 33 without prejudice.

Please add the following new claims:

69. (New) The method of claim 21, wherein:

the optical property pertains to a surface profile of a reflective target surface of the target object; and

step (a) comprises directing the measurement-light flux to the target surface so as to be reflected from the target surface.

70. (New) The method of claim 21, wherein:

the optical characteristic pertains to a wavefront-aberration profile of the target object; and

step (a) comprises directing the measurement-light flux to the target object so as to be transmitted through the target object.

71. (New) The method of claim 70, wherein, in step (a) the measurement-light flux is directed to the target object so as to be transmitted in a first direction through the target object to a reflection member.

72. (New) The method of claim 71, further comprising reflecting the measurement-light flux, that has been transmitted in the first direction through the target object, so as to cause the measurement-light flux to return through the target object in a second direction.

73. (New) The method of claim 72, wherein step (e) comprises moving the standard surface and optionally the reflection member a respective specified distance from a respective standard position.

Please amend claims 34-37 as follows:

34. (Amended) The method of claim [33] 72, wherein the step [(b)] of reflecting the measurement-light flux comprises providing a mirror downstream of the target object so as to reflect the measurement-light flux.

35. (Amended) The method of claim [33] 72, wherein step [(f)] (e) comprises moving both the target object with reflection member and the standard surface while maintaining a constant phase difference between the reference-light flux and the measurement-light flux.

36. (Amended) The method of claim [33] 72, wherein:

step [(e)] (d) further comprises modulating the measurement-light flux; and
in step [(d)] (c) the detected interference is a phase-shift interference.

37. (Amended) The method of claim [33] 72, wherein;

step [(e)] (d) further comprises modulating the reference-light flux; and
in step [(d)] (c) the detected interference is a phase-shift interference.

Please cancel claims 38-43 without prejudice.

Please amend claims 44-46 as follows:

44. (Amended) A projection lens system, comprising the lens element of claim [43] 66.

45. (Amended) A projection lens system, of which the wavefront aberration has been measured using the method of claim [33] 21.

46. (Amended) An apparatus for measuring an optical characteristic of a target object, comprising:

a light source configured to produce a light flux;

a light detector;

an optical system situated relative to the light source and the target object and configured to (i) produce from the light flux a measurement-light flux and a reference-light flux, (ii) direct the measurement-light flux to the target object so as to [reflect from a target surface of] cause the measurement-light flux to interact with the target object and thus acquire a wavefront profile corresponding to the optical characteristic of the target object, (iii) direct the reference-light flux to reflect from a standard surface so as to provide the reference-light flux with a standard wavefront, (iv) establish an interference between the reference-light flux from the standard surface and the measurement-light flux from the target object[;], and (v) direct the interfering reference-light flux and measurement-light flux to the detector;

an actuator situated and configured to move [at least one of the target object and] the standard surface and optionally also the target object a respective specified distance relative to a respective standard location;

a phase-detection device connected to the detector and configured to detect respective phase differences in the detected light, at the various locations resulting from movement, achieved by the actuator, of the [at least one of the target object and the] standard surface and optionally the target object over the respective specified distance; and

a computer configured to determine respective phase distributions from the respective phase differences and to calculate, from the respective phase distributions, an average phase distribution, the average phase distribution corresponding to a measurement of the optical characteristic.

Please add the following new claim:

74. (New) The apparatus of claim 46, wherein the optical system directs the measurement-light flux to the target object so as to cause the measurement-light flux to reflect from a target surface of the target object.

Please amend claims 47-50 as follows:

47. (Amended) The apparatus of claim [46] 74, wherein the optical characteristic is a surface profile of the target object.

48. (Amended) The apparatus of claim [46] 74, wherein the actuator is configured to move the target object relative to the respective standard location.

49. (Amended) The apparatus of claim [46] 74, wherein the actuator is configured to move the standard surface relative to the respective standard location.

50. (Amended) The apparatus of claim [46] 74, wherein the actuator is configured to move both the standard surface and the target object relative to the respective standard locations while maintaining a constant phase difference in the interfering reference-light flux and measurement-light flux.

Please cancel claim 51 without prejudice.

Please add the following new claims:

75. (New) The apparatus of claim 46, wherein the optical system directs the measurement-light flux to the target object so as to cause the measurement-light flux to pass through the target object.

76. (New) The apparatus of claim 75, further comprising a reflection member situated relative to the target object such that measurement light transmitted in a first direction through the target object reflects from the reflection member and returns via a second direction, opposite the first direction, through the target object to interfere with the reference-light flux.

77. (New) The apparatus of claim 75, wherein the actuator is situated and configured to move the standard surface and optionally at least one of the reflection member and target object a respective specified distance relative to a respective standard location.

Please amend claims 52-54 as follows:

52. (Amended) The apparatus of claim [51] 75, wherein the optical characteristic is a wavefront aberration of the target object.

53. (Amended) The apparatus of claim [51] 75, wherein the actuator is configured to move the target object, the reflection member, and the standard surface while maintaining a constant distance between the target object, the reflection member, and the standard surface.

54. (Amended) The apparatus of claim [51] 75, wherein the actuator is configured to move both the target object and the reflection member while maintaining a constant distance between the target object and the reflection member.

Please cancel claim 55 without prejudice.

Please amend claims 57, 60-61, and 63 as follows:

57. (Amended) A lens element, of which the optical characteristic is a surface profile measured using an apparatus as recited in claim [46] 75.

60. (Amended) The apparatus of claim [51] 75, wherein the target object is a lens element.

61. (Amended) A lens element, of which the optical characteristic is a wavefront aberration measured using an apparatus as recited in claim [51] 75.

63. (Amended) A projection lens system, of which the optical characteristic is a wavefront aberration measured using an apparatus as recited in claim [51] 75.